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Canadian Science Advisory Secretariat
Science Advisory Report 2012/059

STOCK ASSESSMENT UPDATE FOR BOCACCIO (*SEBASTES PAUCISPINIS*) IN BRITISH COLUMBIA WATERS FOR 2012

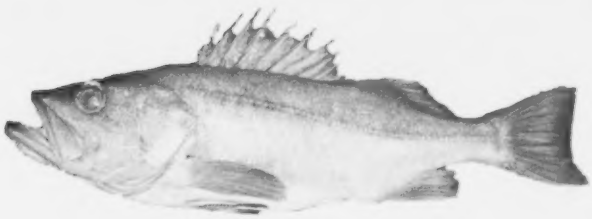

Figure 1. Adult Bocaccio (DFO)

Figure 2. British Columbia waters

Context :

In January, 2004, the Minister of the Environment received a document on Bocaccio from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC,) which assessed the Bocaccio population in British Columbia waters as threatened. Following consultation, the assessment was referred back to COSEWIC for further information and consideration in April, 2006. In December 2006, COSEWIC reaffirmed the original assessment without reassessing the species, citing an absence of new information that would lead to a change in the status of this species.

Following extensive review, the Governor in Council decided, in 2011, not to add Bocaccio to the List of Wildlife Species at Risk. This decision was based on the recommendation of the Minister of the Environment and advice from the Minister of Fisheries and Oceans, taking into account the assessments provided by COSEWIC and those provided by DFO. It was determined that the costs of protection under SARA would likely outweigh the benefits to Canadians. However, the statement noted that protective measures would be taken under existing legislative tools, such as the Fisheries Act, as well as non-legislative tools, such as government programs and actions by non-governmental organizations. Among the steps taken to provide protection to the Bocaccio population, an updated DFO assessment of Bocaccio was scheduled for review in 2011. This report summarizes the results of that assessment.

This Science Advisory Report is from the May 29, 2012 meeting on the Updated assessment of Bocaccio Rockfish in British Columbia. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule at www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Canada

SUMMARY

This assessment:

- updates the 2009 published assessment with four more years of data, the inclusion of recreational catch, an additional survey, and minor technical modifications.
- is based on the reference case with a median estimate of B_{2012}/K (the ratio of current stock size to the unfished stock size) of 3.5% (90% confidence limits of 1.4-9.1%). The median estimate of B_{2012}/B_{msy} (the ratio of current stock size to that at maximum sustainable yield) is 7.0%, with 90% confidence limits of 2.9-18.2%.
- estimates the stock to have a 99% probability of being in the provisional DFO Precautionary Approach critical zone, whereby $B_{2012}<0.4*B_{msy}$.
- explored a large number of sensitivity runs to test many of the model assumptions. While there was considerable uncertainty in these runs, all were consistent in indicating that $B_{2012}<0.4*B_{msy}$.
- indicates, in the reference case, that there is at least a 90% likelihood that the population has continued to decline since 2002, despite total catches being among the lowest in the history of the fishery.
- indicates that current harvests are approximately equal to the median estimate of replacement yield.
- provides population projections over 5, 20 and 60 years under varying assumptions of fixed catches and makes predictions relative to the PA provisional reference points of $0.4*B_{msy}$ and $0.8*B_{msy}$.

INTRODUCTION

In January, 2004, the Minister of the Environment received a document on Bocaccio (*Sebastes paucispinis*) from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) which assessed the Bocaccio population in British Columbia (BC) waters as threatened (COSEWIC 2002). This prompted the Department of Fisheries and Oceans Canada (DFO) to conduct extended consultations with the government of BC, Aboriginal peoples, stakeholders, and the public on whether or not the Bocaccio population should be added to the List of Wildlife Species at Risk (Schedule 1) under the Species at Risk Act (SARA). Results of these consultations led the Governor in Council, through the Minister of the Environment, in April, 2006, to refer the assessment back to COSEWIC for further information and consideration[1].

In December 2006, COSEWIC reaffirmed the original assessment without reassessing the species, citing an absence of new information that would lead to a change in the status of this species. In 2010, the Government of Canada, on the recommendation of the Minister of the Environment, acknowledged receipt of the COSEWIC Bocaccio assessment conducted under subsection 23(1) of SARA.

Following extensive review, the Governor in Council decided, in 2011, not to add Bocaccio to the List of Wildlife Species at Risk. This decision was based on the recommendation of the Minister of the Environment and advice from the Minister of Fisheries and Oceans, taking into account the assessments provided by COSEWIC and those provided by DFO (DFO 2009, Stanley et al. 2009). It was determined that the costs of protection under SARA would likely outweigh the benefits to Canadians. However, the statement noted that protective measures would be taken

[1] Species at Risk Public Registry page for Bocaccio (including links to recommendations and decisions): http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=740

under existing legislative tools such as the Fisheries Act, as well as non-legislative tools such as government programs and actions by non-governmental organizations.

Among the steps taken to provide protection to the Bocaccio population, an updated DFO assessment of Bocaccio was scheduled for review in 2011 or 2012, coinciding with a COSEWIC re-assessment scheduled for 2011. The basic objectives of the assessment were to:

- update the previous assessment with four more years of data (2008-2011);
- enhance the previous model;
- provide, with rationale, a Limit Reference Point and an Upper Stock Reference, guided by the DFO Sustainable Fisheries Framework (DFO 2009b);
- assess the status of the stock relative to the recommended reference points;
- predict the consequences of varying harvest levels on future population trends.

This report summarizes the recent assessment. We refer readers to it and previous documents (DFO 2009, Stanley et al. 2009) for more details on the methods used to in this assessment and some earlier results that remain unchanged.

ASSESSMENT

Consistent with previous documents, Bocaccio is treated as a single coastwide stock in BC waters. The distribution of Bocaccio commercial catch observations in BC waters is provided in Figure 3. This figure shows the location of capture for all observations of Bocaccio in the most recent 10 years (2002-2011) and indicates a widespread distribution of Bocaccio in BC coastal waters. We did not attempt to examine whether distribution has changed over time. The commercial catch data are not comparable over longer periods, and the available survey time series are too discontinuous and imprecise to provide sufficient comparability to undertake such an analysis.

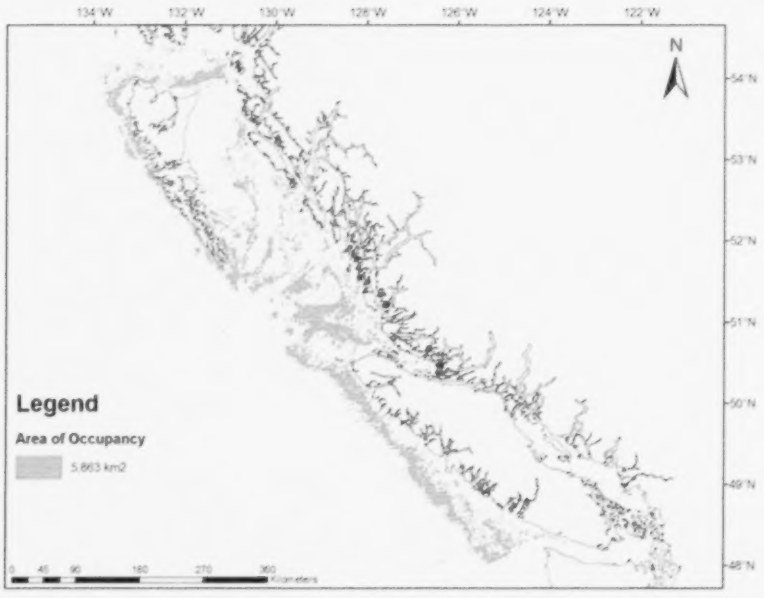

Figure 3. Area of occupancy for Bocaccio based on survey and commercial observations from 2002-2011 (commercial trawl 2002-2011; commercial HL 2006-2011). Figure indicates all 2 km x 2 km cells with at least one record of Bocaccio capture.

Model Inputs

Estimates of the Bocaccio growth and age-at-maturity parameters were updated with additional sample data, with the estimated age at 50% maturity declining from 8.5 to 7.1 years. This did not change the estimate of generation time, which is still approximately 20 years. The time series of Bocaccio catch in the groundfish trawl and groundfish hook-and-line (HL) (rockfish sectors) were updated and implemented in the model as being fixed and known without error (Figure 4). The halibut HL and salmon troll data were updated and incorporated in the model as a time series of effort, using the methodology described for previous assessments. Recreational catches, although relatively small in terms of overall Bocaccio catch, were added for the first time to the model using an effort-based methodology, similar to that used for the salmon troll and halibut HL fisheries (Figure 5). The assessment included eight relative abundance indices, including a fishery dependent bottom trawl CPUE index (1996-2004) (Figure 6) and seven fishery independent surveys, all but one of which are currently operated (Figure 7 and Figure 8).

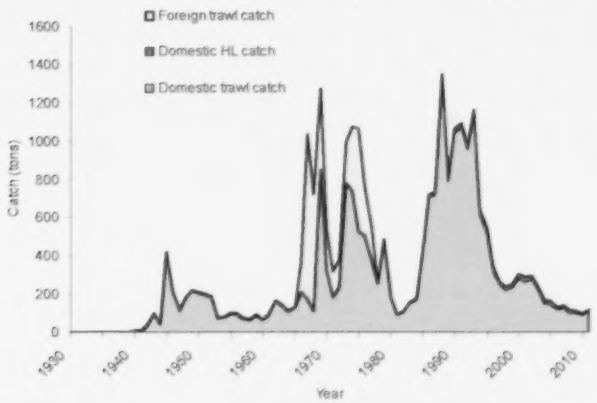

Figure 4. Domestic (U.S. and Can.) and foreign trawl landings (1930 to 2011).

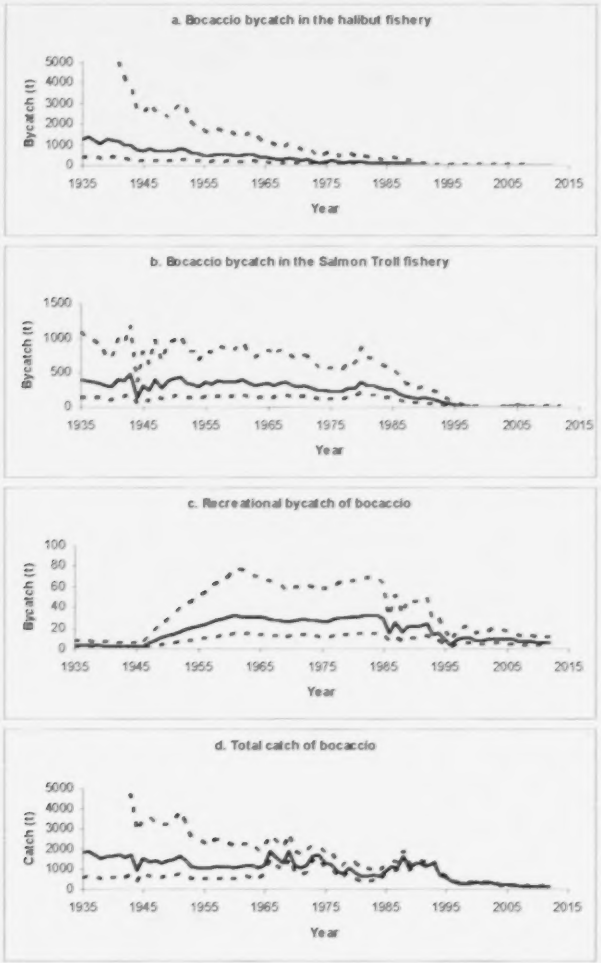

Figure 5. Median and 80% probability intervals for catch of Bocaccio (retained and discarded) in the: a. halibut fishery, b. salmon troll fishery, and c. recreational fishery, d. all sectors combined including trawl and ZN HL. Note the large differences in scale on the y-axis.

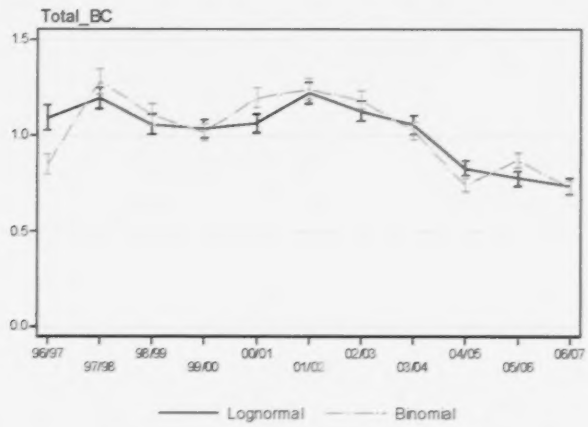

Figure 6. Lognormal and binomial standardised CPUE indices for Bocaccio. The error bars show ± 95% confidence bounds. Note that the fishery voluntarily stopped targeting on Bocaccio in 04/05, so only 96/7-03/04 values were input to the model.

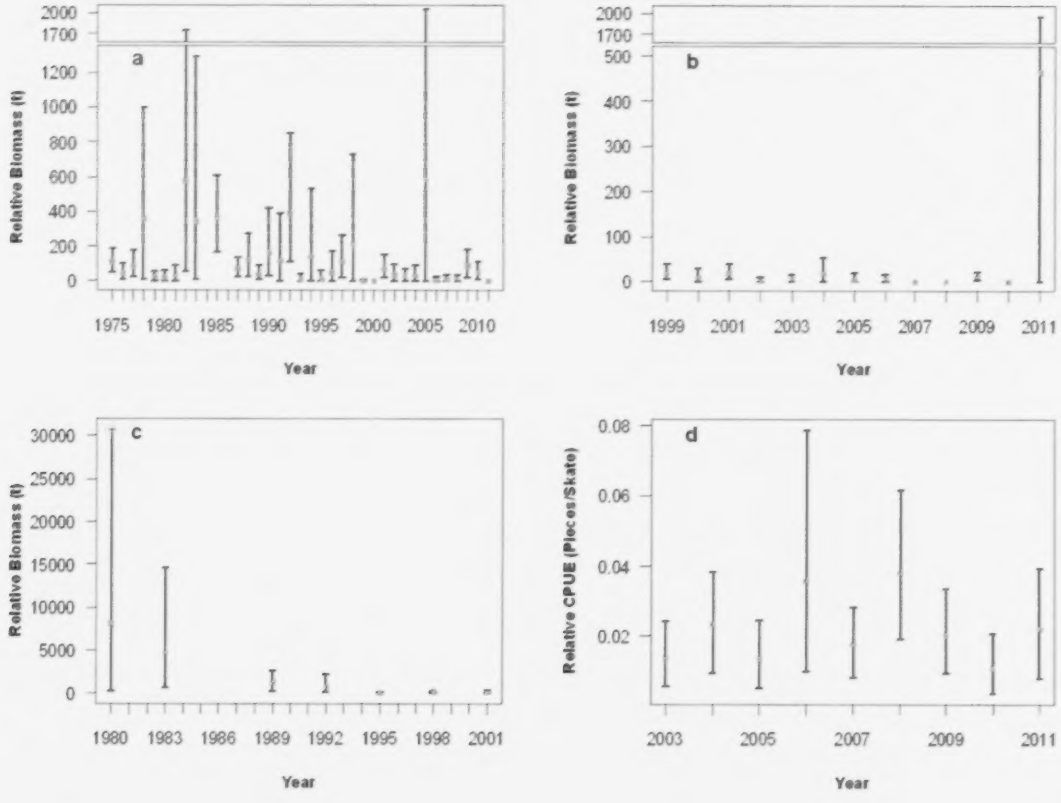

Figure 7. Plots of biomass estimates for Bocaccio from the a. West Coast Vancouver Island shrimp trawl, b. Queen Charlotte Sound shrimp trawl, c. U.S. Triennial survey, and d. IPHC setline surveys. Bias corrected 95% confidence intervals from 1,000 bootstrap replicates are plotted.

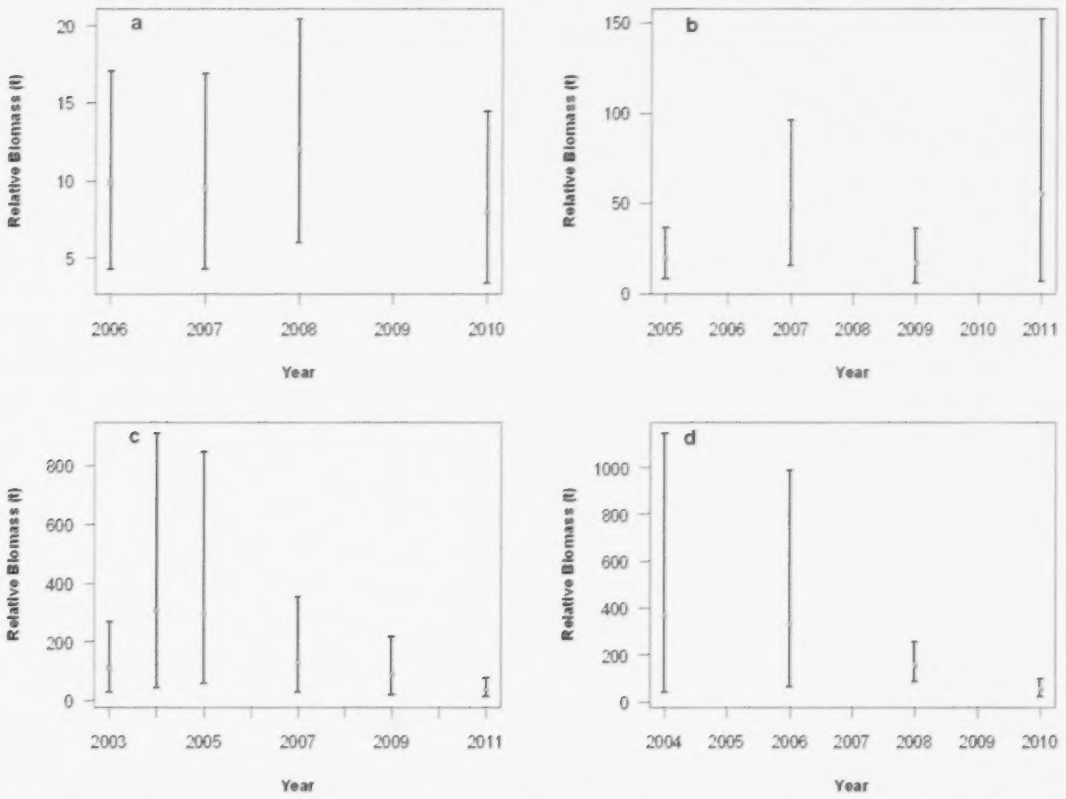

Figure 8. Plot of biomass estimates for Bocaccio from the a. West Coast Haida Gwaii; b. Hecate Strait, c. Queen Charlotte Sound and, d. West Coast Vancouver Island Groundfish Synoptic trawl surveys for 2003 to 2011. Bias corrected 95% confidence intervals from 1000 bootstrap replicates are plotted.

Results

This assessment used the non-equilibrium, age-aggregated Bayesian surplus production model described in Stanley et al. (2009). Overall results were similar to previous work, in that the reference case indicates that Bocaccio exploitable stock biomass had declined significantly from the 1930s, with the steepest decline occurring from 1985 to 1995 (Figure 9 and Table 1). The rate of decline slowed after 1995, coincident with lower catches of the early 1990s, however, the decline has continued after 2000 (Figure 9c).

The posterior median estimate for exploitable biomass in 2012 is 1,879 t (*CV*=55%). The posterior median estimate of stock size relative to its unfished stock size (B_{2012}/K) is 3.5%. Current abundance relative to B_{msy} (B_{2012}/B_{msy}) is 7%. The 90% confidence limits of the median estimate of B_{2012}/B_{msy} lie between 0.029 and 0.182. There is a 99% mean probability that the population is less than the lower Precautionary Approach (PA) reference point of $0.4*B_{msy}$. The posterior median estimate for the replacement yield in 2012 is 143 tons (*CV*=55%), similar to current catch levels (Figure 9).

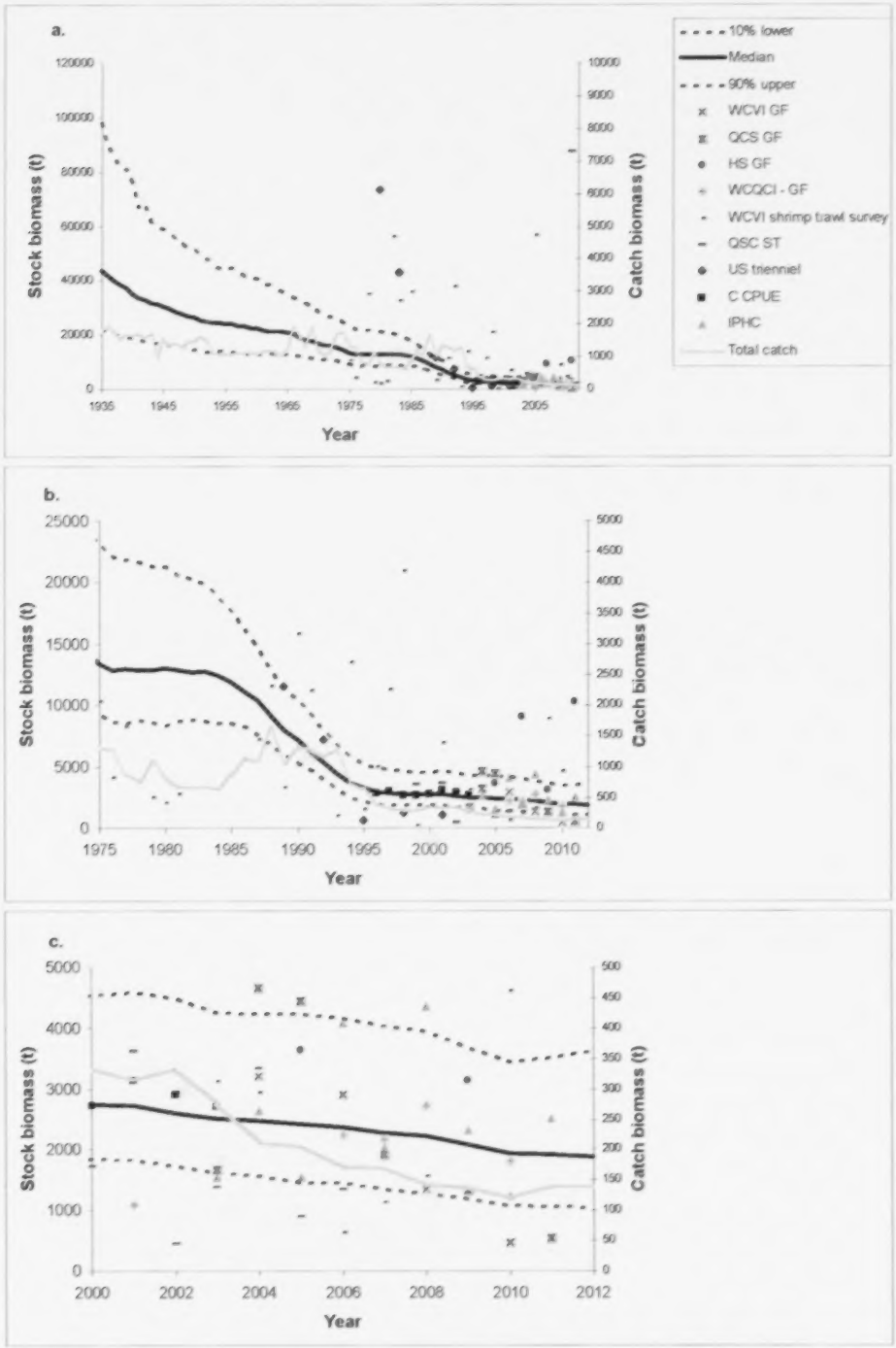

Figure 9. Plots of median and 80% probability intervals and indices rescaled by their median a. 1935-2012; b. 1975-2012; c. 2000-2012. Note that some of the very large values for some of the indices are not shown in panels b. and c. to permit closer inspection of more recent trends

Table 1. Reference case 2012 stock assessment statistics. Biomass and yield values are in metric tonnes. RepY=replacement yield. F_{2012} and F_{msy} are the instantaneous fishing mortality rates in 2012 and at MSY, respectively.

Variable	10th Percentile	Median	90th Percentile
K	26,461	52,330	116,664
B_{msy}	13,231	26,165	58,332
B_{2012}	1,031	1,879	3,625
B_{2012}/B_{msy}	0.029	0.07	0.182
B_{2012}/K	0.0144	0.0351	0.0911
F_{2012}	0.041	0.0742	0.1289
F_{2012}/F_{msy}	1.03	1.90	3.58
RepY	75	143	287
Catch/RepY	0.570	0.990	1.811
B_{2011}/B_{2001}	0.46	0.66	0.97
$P(B_{2012}>0.4B_{msy})$		0.01	

The posterior median ratio of stock size in 2011 relative to 2001 is 0.66, with 10th and 90th percentiles at 0.46 and 0.97. The 90% probability interval for this statistic is 0.42 and 1.09. These results indicate that there is at least a 90% probability that stock size is lower in 2011 than it was 10 years ago.

Sources of Uncertainties

While the Bayesian approach used in this assessment provides a formal mechanism to include uncertainty in model output (including predictions), managers and stakeholders are advised that not all sources of uncertainty have been addressed, and that it is likely that the true uncertainty is even greater than that presented here. The major sources of these uncertainties include additional imprecision in the surveys and the assumption that Bocaccio productivity, as well as availability and catchability in the surveys and fisheries, have been constant over time. The possible impact of some of these assumptions was examined with sensitivity tests (runs with alternative model assumptions). All sensitivity tests were consistent in indicating that current biomass is in the critical zone.

CONCLUSIONS AND ADVICE

Decision tables are presented to help guide discussion of harvest strategies for Bocaccio. Table 2 provides a summary decision table, based on the reference case, for the probability that stock biomass will exceed $0.4*B_{msy}$ within 60 years under alternative constant catch policies (catches expressed in tonnes). For example, it indicates that catches of less than 125 t/year are required to achieve at least a 50% probability of exceeding the LSR point ($0.4*B_{msy}$) within three generations (60 years). Only slightly different predictions were obtained under a range of stock productivity assumptions and other sensitivity runs. Current total harvest (approximately 137 t/year) is approximately equal to the reference case estimate for replacement yield (median estimate of 143 t), the yield which will maintain the current biomass. Managers are reminded, however, that there is great uncertainty in these long term projections, and are based on the assumption that catches would remain constant over 60 years (Figure 10).

Table 2. Stock status indicators Bocaccio after 5, 20, and 60 years for the reference case (subscripted as 'fin' in this table). Policies are constant TAC policies in t/year. The statistics P(B>0.X B_{msy} in Hz) refer to the probability that stock size exceeds 0.X B_{msy} within the stated horizon (Hz).*

Horizon	Policy	Median (B_{fin}/K)	Median (B_{fin}/B_{msy})	P($B_{fin}>B_{2012}$)	P($B>0.4B_{msy}$ in Hz)	P(B>$0.8B_{msy}$ in Hz)
5 -year	0	0.05	0.10	0.76	0.05	0.01
	50	0.05	0.09	0.67	0.05	0.01
	75	0.04	0.08	0.63	0.05	0.01
	100	0.04	0.08	0.59	0.05	0.01
	125	0.04	0.07	0.53	0.04	0.01
	150	0.03	0.07	0.48	0.04	0.01
	175	0.03	0.06	0.43	0.04	0.01
	200	0.03	0.06	0.37	0.04	0.01
20 -year	0	0.16	0.33	0.88	0.43	0.21
	50	0.12	0.23	0.78	0.36	0.18
	75	0.10	0.19	0.69	0.32	0.16
	100	0.07	0.15	0.61	0.28	0.14
	125	0.05	0.10	0.52	0.25	0.12
	150	0.03	0.05	0.46	0.22	0.11
	175	0.01	0.02	0.41	0.19	0.10
	200	0.00	0.00	0.34	0.17	0.09
60 -year	0	0.65	1.29	0.95	0.86	0.77
	50	0.56	1.11	0.81	0.72	0.65
	75	0.44	0.88	0.69	0.65	0.58
	100	0.27	0.54	0.60	0.56	0.51
	125	0.06	0.11	0.50	0.49	0.44
	150	0.00	0.000	0.44	0.42	0.38
	175	0.00	0.000	0.37	0.37	0.33
	200	0.00	0.000	0.30	0.30	0.26

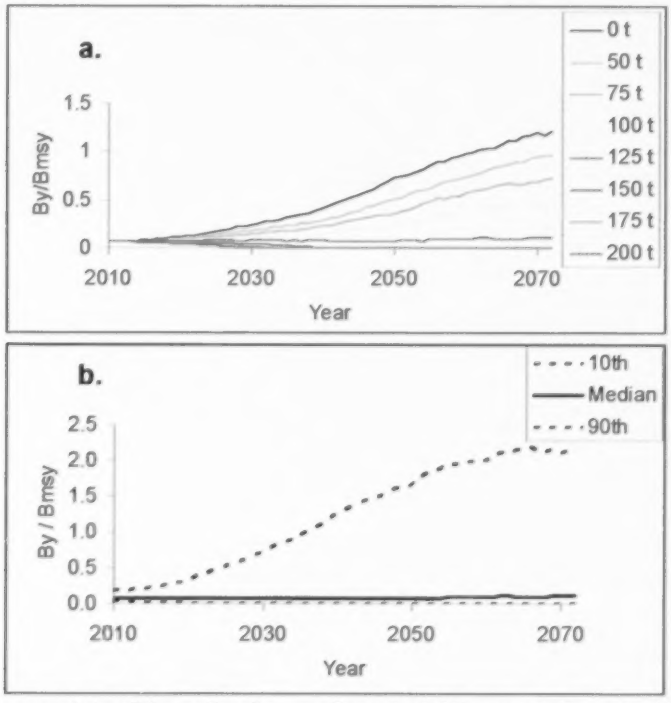

Figure 10. Reference case plots of the ratio of a. median stock biomass to B_{msy} for different constant total catch policies and b. 10th, 50th (median) and 90th percentiles for this ratio under a constant total catch of 125 t, demonstrating the uncertainty of the long-term projections.

SOURCES OF INFORMATION

This Science Advisory Report is from the May 29, 2012 meeting on the updated assessment of Bocaccio Rockfish in British Columbia. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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